

## 6.0 ENVIRONMENTAL ISSUES

This chapter discusses the adverse effects of LFG and the benefits of LFG control.

Environmental issues associated with LFG emissions include human health, the environment, and safety. Solid waste LFG presents a potential hazard to human health and the ecological system if left uncontrolled. LFG can be:

- explosive,
- corrosive,
- odorous,
- toxic, and
- asphyxiating.

Therefore, proper control of LFG is essential to ensure the well being of public health and the environment.

Gases found in landfills include air, ammonia,  $\text{CO}_2$ , carbon monoxide, hydrogen,  $\text{H}_2\text{S}$ ,  $\text{CH}_4$ , nitrogen and  $\text{O}_2$ . In addition, various organic compounds may be present in the gas depending on the types of wastes placed in the landfill.  $\text{CO}_2$  and  $\text{CH}_4$  are the principal gases produced from the anaerobic decomposition of organic solid waste components. The high initial percentage of  $\text{CO}_2$  is the result of aerobic decomposition. The potential adverse effects which can be caused by LFG emissions are further described in the following paragraphs.

## 6.1 EFFECTS ON HUMAN HEALTH

LFG can asphyxiate a person in an enclosed area or confined space. Enclosed areas include trenches, vaults, underground storage tanks, or building foundations. A confined space is defined by OSHA as a space that:

- is large enough and so configured that a person can bodily enter and perform work,
- has limited or restricted means for entry or exit, and
- is not designed for continuous human occupancy.

The combustion of LFG can also pose a serious health risk to nearby residents and landfill operating personnel. LFG can migrate into confined spaces and can ignite causing serious property and human health damage.

#### 6.2 TOXICOLOGICAL PROFILES OF LFGs

Typical municipal LFGs include CH<sub>4</sub>, CO<sub>2</sub>, nitrogen, paraffinic hydrocarbons, polycyclic aromatic hydrocarbons, hydrogen, H<sub>2</sub>S, CO, benzene, vinyl chloride, toluene, 1,2-dichloroethane, chloroform (trichloromethane), 1,1,1-trichloroethane, carbon tetrachloride, and tetrachloroethene, among others. Combustion of LFGs will result in products such as CO<sub>2</sub>, water, sulfur compounds, and hydrogen chloride along with trace amounts of gases that may result from incomplete combustion of parent compounds. Toxicological profiles of specific chemicals are summarized in Table A-7.

#### 6.3 EFFECTS ON SOIL/VEGETATION

LFG, for the most part, does not have adverse effect on soil after it has passed through it. The LFG moves through the pore space within the soil, and once the gas has evacuated the pore space, the soil returns to its initial condition.

CH<sub>4</sub> gas generated in landfills kills vegetation. The gas displaces the O<sub>2</sub> from the root zone and thus chokes off the plant.

#### 6.4 ODOR PROBLEMS

Landfill odors emanate from open areas of the site due to the decomposition of solid waste and hence the production of LFG. Typically, the strong odors that emanate from LFG are due to ammonia and sulfide constituents that are in the gas. Contrary to popular belief, CH<sub>4</sub> and CO<sub>2</sub> are both odorless and colorless.

Odors from landfills can have adverse public health impacts. Apart from being unpleasant for nearby residents, odors can attract insects and other vermin, such as rats, pigeons, seagulls and bears.

Table A-7  
Toxicological Profiles of Select Landfill Emissions

Chemical	CAS No. <sup>1</sup>	Chemical State	Health Hazard	ACGIH TLV <sup>2</sup>	OSHA PEL <sup>3</sup>	Combustion Products
Ammonia	7664-41-7	Gas (pungent suffocating odor)	Eye, nose, throat irritant, skin burns, pulmonary edema, chest pain, bronchial spasms; corrosive	TWA <sup>4</sup> - 25 ppm STEL <sup>5</sup> - 35 ppm	TWA - 50 ppm	NO <sub>x</sub> , H <sub>2</sub> O
Benzene	71-43-2	Liquid (sweetish odor)	Group 1 Human Carcinogen; skin irritant and inhalation absorption; short-term exposure results in drowsiness, dizziness, headaches and digestive system irritation.	TWA - 10 ppm	TWA - 1 <sup>6</sup> ppm/ 10 <sup>7</sup> ppm	H <sub>2</sub> O, CO <sub>2</sub> ; also carbon under non-oxidative conditions
Carbon Dioxide	124-38-9	Gas	Simple Asphyxiant	TWA - 5000 ppm STEL - 30,000 ppm	TWA - 5,000 ppm	Fully oxidized
Carbon Monoxide	630-08-0	Gas	Flammable, inhibition of cell oxidation following inhalation	TWA - 25 ppm	TWA - 50 ppm	CO <sub>2</sub>
Carbon Tetrachloride	56-23-5	Liquid (sweet aromatic odor)	Group 2B Possible Human Carcinogen; Short-term inhalation: hemorrhagic congestion, edema of lungs, renal injuries, dyspnea, nausea, vomiting and gastrointestinal pain, swollen and tender liver, jaundice, nephritis and nephrosis, skin rashes and CNS <sup>8</sup> depression	TWA - 5 ppm STEL 10 ppm	TWA - 10 ppm (C) <sup>9</sup> - 25 ppm <sup>7</sup>	CO <sub>2</sub> , H <sub>2</sub> O, HCl, phosgene
Chloroform	67-66-3	Liquid (Sweet odor)	Group 2B Possible Human Carcinogen; respiratory adsorption; CNS depression, anesthesia, cardiac sensitization; skin irritation	TWA - 10 ppm	(C) - 50 ppm	H <sub>2</sub> O, CO <sub>2</sub> , HCl, phosgene.
1,2-Dichloroethane (Ethylene dichloride)	107-06-2	Liquid	Group 2B Possible Human Carcinogen; Respiratory tract irritation, circulatory failure, CNS depression, cough, nausea or vomiting, cyanosis, coma; dermatitis, eye irritation.	TWA - 10 ppm	TWA - 50 ppm (C) - 100 ppm <sup>7</sup>	H <sub>2</sub> O, CO <sub>2</sub> , H <sub>2</sub>
Hydrogen	1333-74-0	Gas	Flammable, explosive, simple asphyxiant	No TLV: Concentration of oxygen is limiting factor.	No PEL: Concentration of oxygen is limiting factor.	H <sub>2</sub> O
Hydrogen Sulfide	7783-06-4	Gas (odor of rotten eggs)	Flammable, respiratory absorption, inhibition of cellular respiration leading to death, coma, convulsions, apnea, pulmonary edema, irritated eyes, conjunctivitis, dizziness, headaches, cough, insomnia, nausea	TWA - 10 ppm STEL - 15 ppm	TWA - 10 ppm (C) - 20 ppm <sup>7</sup>	H <sub>2</sub> O, SO <sub>2</sub> , SO <sub>3</sub>
Methane	74-82-8	Gas	Flammable, explosive, simple asphyxiant	No TLV: Concentration of oxygen is limiting factor.	No PEL: Concentration of oxygen is limiting factor.	H <sub>2</sub> O, CO <sub>2</sub>
Nitrogen	7727-37-9	Gas	Simple Asphyxiant	No TLV: Concentration of oxygen is limiting factor.	No PEL: Concentration of oxygen is limiting factor.	Inert

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Chemical	CAS No. <sup>1</sup>	Chemical State	Health Hazard	ACGIH TLV <sup>2</sup>	OSHA PEL <sup>3</sup>	Combustion Products
Polycyclic Aromatic Hydrocarbons (as coal tar pitch volatiles)	Glass	Solids	Group 1 Human Carcinogens: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene.	TWA - 0.2 mg/m <sup>3</sup> for benzene-soluble fraction of coal tar pitch volatiles (including benzo(a)pyrene)	TWA - 0.2 mg/m <sup>3</sup>	H <sub>2</sub> O, CO <sub>2</sub> ; also carbon under non-oxidative conditions.
Toluene	108-88-3	Liquid (sweet odor)	Flammable; absorbed from respiratory and gastrointestinal tract; short-term inhalation lightheadness, euphoria, dizziness, sleepiness, unconsciousness, death; skin irritation and dryness; eye irritation	TWA - 100 ppm	TWA - 200 ppm (C) - 300 ppm <sup>7</sup>	Carbon, CO <sub>2</sub> , H <sub>2</sub> O
1,1,1-Trichloroethane (Methyl chloroform)	71-55-6	Liquid (ethereal odor)	Short-term inhalation: anesthesia, CNS depression and/or fatal arrhythmias; skin irritation; long term dermal contact: edema, erythema, inflammation, cellular degeneration	TWA - 350 ppm STEL - 450 ppm	TWA - 350 ppm	H <sub>2</sub> O, CO <sub>2</sub> , HCl, phosgene
Vinyl Chloride	75-01-4	Gas (sweet odor)	Flammable, peroxide former; Group 1 Human Carcinogen; long term exposure dizziness, nausea, headache, tingling sensations, fatigue, bone swelling, circulatory disorders, CNS system disorders, lung function impairments, immune system dysfunction	TWA - 5 ppm	TWA - 1 ppm STEL - 5 ppm	CO <sub>2</sub> , CO, HCl, phosgene

<sup>1</sup> - Chemical Abstracts Registry Service Number.  
<sup>2</sup> - American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV), 1991 6th Edition.  
<sup>3</sup> - Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL), 29 CFR 1910.1000 Table Z-1.  
<sup>4</sup> - TWA - Time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.  
<sup>5</sup> - STEL - Short-term exposure limit or a 15-minute TWA exposure which should not be exceeded at any time during the workday even if the 8-hour TWA is within the TLV-TWA.  
<sup>6</sup> - OSHA 29 CFR 1910.1028  
<sup>7</sup> - OSHA 29 CFR 1910.1000 Table Z-2  
<sup>8</sup> - Central Nervous System (CNS)  
<sup>9</sup> - Ceiling (C)

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Odor problems from a landfill mostly occur when a landfill is open (i.e., in operation). Closed landfills should include design provisions for odor containment, whether it be through a gas flaring system or through controls such as carbon filtration units.

#### 6.5 NOISE AND VISIBILITY

The aesthetics of constructing a LFG control system must be incorporated into the final design. Unsightly and/or noisy resource recovery systems, flaring systems, or passive gas venting systems can cause public outcry.

#### 6.6 EXPLOSION AND FIRE POTENTIAL

CH<sub>4</sub> gas is explosive between 5 and 15 percent concentration in air. The uncontrolled release of CH<sub>4</sub> gas can be very dangerous. CH<sub>4</sub> gas has been documented to accumulate in basements of buildings and/or residential homes, and has exploded causing serious injury to people and property.

CH<sub>4</sub> gas entry points into a building may be through cracks, construction joints, subsurface utility service openings, and almost any other weak spot in the basement wall or building floor. CH<sub>4</sub>, being lighter than air, will tend to accumulate near the ceiling.

The uncontrolled release of CH<sub>4</sub> in subsurface strata poses a substantial risk of underground fires as well as explosions. Underground fires from CH<sub>4</sub> are common in peat bogs and swamps as well as landfills during arid weather conditions. Proper LFG controls such as passive gas systems can eliminate the potential for underground fires.